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Geological investigation of the proposed Grand Coulee Reservoir

by

O.P. Jenkins and H.H. Cooper

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Pullman, Washington.
July 15, 1921.

Director D. A. Scott,
Department of Conservation and Development,
Olympia, Washington.

Sir:

In pursuance of your instructions the following report is submitted as the result of a geological investigation of the proposed Grand Coulee reservoir.

Object.

The object of the examination was to determine whether or not the Grand Coulee would hold water if used as a reservoir.

Conditions Proposed.

According to the proposed conditons of the Columbia Basin Survey, water from the Columbia River would be raised from that stream and emptied into the north end of the Grand Coulee. The retention of this water in the proposed reservoir would necessitate the construction of two dams across the Coulee - one near the north end, and the other across the south end, two miles north of Coulee City. The water level of the proposed reservoir would be 1552.5 feet above sea level, taking the United States Geological Survey Bench Mark at the Station in Coulee City as the datum point at 1584.089 feet. Hence the reservoir would be approximately 30 miles long, one-half to two and one-half miles wide, with a maximum depth of 50 to 60 feet. The reservoir would, therefore, not cover the entire floor of the Coulee and only in places would it reach the base of the great walls of rock which bound its east and west sides.

Conclusions.

After one week's study of the geological formations of the region, their character, their relation one to another, and their structure or "lay", the following conclusions have been reached.

1. That the most likely point in the Grand Coulee for possible underground leakage is in the vicinity of the proposed dam site at the southern end, north of Coulee city. If this southern dam were placed two and one-half or three miles north of the present dam site, which is located near

the Ohlwell Ranch, an unfavorable geological feature (a fault combined with a sharp monoclinal fold, crossing diagonally the southern end of the Grand Coulee) would be eliminated.

2. That leakage around the ends of this southern dam, especially around the eastern end might be quite possible and would warrant careful consideration of the underground conditions beyond the limit of the dam as well as beneath the dam itself.

3. A dam so placed between the sides of the Coulee that solid rock would form the retaining wall where the dam leaves off would eliminate possible leakage, since the loose filling material - sand, gravel, silt and clay - is all more or less pervious and might in time cause serious trouble if depended upon as a container.

4. The granite of the Coulee is undoubtedly water-tight, excepting its surface portion, which is, in places, jointed or filled with cracks.

5. The basalt layers which form the walls of the Coulee vary in denseness. A small amount of seepage occurs along the planes of contact of these layers, especially where more porous beds prevail. Leakage along such seepage planes in the walls of the Coulee would probably be superficial, especially where the beds lie horizontally or nearly so.

6. The loose material - sands, gravels, silt, and clay - which fills the lower portion or floor of the Grand Coulee and conceals from view the underground bedrock, should not be depended upon as impervious material, even though in places it has proved so locally. So long as the dams at either end of the reservoir connect the bed rock of the Coulee from one side to the other, this loose material need not be given consideration, for it would be trapped within the reservoir basin.

Geological Features.

Formations present.

Granite. The oldest underlying rocks of the entire region which are exposed are granite. This granite is a tightly crystallized homogeneous rock, which would allow the circulation of underground water only along joint planes and local cracks. Over the old eroded surface of the granite basaltic flows of lava were once poured. It is evident that the basalt overlies the granite from exposures in the region north of Steamboat Rock and where the Grand Coulee enters the Columbia River gorge.

Basalt. The overlying basalt layers vary in compactness from dense rock to porous, cellular material, and to layers of cinders and agglomerate. As far as was observed, the layers nearer the base against the granite are fairly dense, while some of the upper layers, above the general water-level of the proposed reservoir, are, in places quite cellular containing some agglomerate beds of limited extent. The lower beds would come into contact with the

water of the reservoir, while the upper beds would need to be considered only at the southern end of the Coulee where a great monoclinal fold and fault has caused the younger, more porous beds to be brought down into the floor of the Coulee itself.

Seepage through the upper layers of basalt, resulting in the formation of springs, is in evidence in a number of places along the walls of the Coulee, but it is not a very pronounced feature. It is quite probable that since the beds are in most cases lying nearly horizontal this seepage is not great, but where the beds are tilted, migration of the water would be increased down the planes of the dipping beds.

Terrace sands and gravels. Remnants of terrace gravels and sands are to be found within the Coulee in protected places, high against the walls of the Coulee, and nearly a hundred feet above the level of the surface of the proposed reservoir, lying on the same level as the very uppermost terraces of the Columbia River gorge. This material may extend in depth to the bottom of the Coulee Basin.

Terrace silt. At a lower elevation than the top of the terrace gravels described above, are extensive, fine, silt deposits which form low terraces whose tops are at a slightly higher elevation than the water-level of the proposed reservoir. This material is a basin deposit which is in places partially impervious to surface water. A large reservoir would, however, spread water over a large enough territory so that such surface water would probably work down into the underlying loose material.

All of this sand, gravel and clay material which covers the Coulee floor is of importance only as an absorptive medium for water brought onto the land and should be considered in respect to leakage only at the ends of the Coulee where the confining dams would be placed.

Lakes existing at present in the Coulee.

The lakes present in the Coulee are of considerable importance as indicators that the Coulee would hold water even if filled to considerable depth. It is a recognized fact that a lake cannot become alkaline or salty to any great extent if it has an outlet, and a circulation of fresh water takes place through it. There are alkaline and salty lakes within the Grand Coulee. Their reduction in size during the summer months of the year is due to surface evaporation. The alkaline lake at the southern end of the Coulee therefore has at present no outlet, surface or underground. Under the great pressure of a deep lake or reservoir, underground drainage might be set up in some way, although there is no proof that it would. It must be understood, however, that the length of the reservoir has nothing to do with its pressure, only depth is to be considered in this regard.

Underground water of the Coulee.

Judging from the presence of water beneath the surface of

the alluvial filling of the Grand Coulee, as proved by a number of wells, which are not much over 50 feet deep, the loose material which covers this part of the region is already fairly well saturated with water. This signifies that if the Coulee were filled with water in order to make it a reservoir, there would be only a limited amount of absorption in this material. The records of the wells show that underground water occurs in gravel which lies beneath upper layers of more impervious clay-like sediment. Bed rock has not been reached in any of these wells. It would be interesting and it might throw considerable light upon the subject of absorption as well as drainage around the ends of the dams if a few typical holes were drilled in the center of the Coulee to bed rock and records kept of their logs.

Geological structure.

The most pronounced and important structural feature of the rock formations of the region are present in the layers of basalt. In general these layers lie in a horizontal position, but in some places they lie in low folds. This feature is especially evident in the region where the granite is exposed. Along one particular belt, not over one-quarter of a mile wide, running in a northeast-southwest direction is a steep monocline accompanied by a probable break or a displacement in the rocks known to geologists as a fault. This fold and fault crosses the southern end of the Grand Coulee a half mile north of the dam site located near the Ohlwell Ranch. The dipping beds of the basalt are plainly in evidence on either side of the Coulee and can be traced down to Blue Lake where a complete exposure reveals the character of this structural feature. The beds of basalt in the great wall dip southeastward at an angle of nearly 45° and are lost underground even below the level of Blue Lake. The beds of basalt which form the cliff face of the Dry Falls and also form the material upon which the dam site north of Coulee City is located are not the same beds which form the walls of the Grand Coulee. They are layers which were poured out on top of the layers exposed in the Coulee walls, even though they now lie at a much lower elevation.

Although this structural feature might not interfere with the reservoir, it would be unwise to place the dam so that the fold and fault lay within the reservoir. There might not only be leakage along this fault line, but this line is one of the lines of weakness in the earth's crust and it is possible that slight displacements might take place there from time to time as they undoubtedly have done in the past.

Recommendations.

The following recommendations are herewith submitted:

(1). That the dam site at the southern end of the Grand Coulee near Coulee City be reconsidered in view of the geological conditions known to exist there. It may become

necessary to examine by drilling any new dam site located north of the present one in order to locate bed rock.

(2) That during the course of drilling a geologist be consulted in regard to the material encountered in the drill holes.

(3) That special geological consultation would be beneficial before actual construction of any of the dams be started.

(4) That a topographic map of the Grand Coulee, Dry Falls, and immediate vicinity be constructed in cooperation with the United States Geological Survey for publication, and that a geological map be constructed of the region before the reservoir is completed, using the topographic map thus made as a base.

Respectfully submitted,

Olaf P. Jenkins

Geologist in Charge of Field Work.

Arrochel H. Cooper

Assistant Field Geologist.

Illustrations.

The following illustrative photographs are arranged so that they may logically accompany the written report. They should, however, be observed in direct connection with a study of the geological map prepared especially for this work. The base for the map was taken from a sketch map originally prepared by Mr. Turner of the Columbia Basin Survey. Additions to this were made from field observations of the geological conditions and from notations from the profile maps of the Columbia Basin Survey.

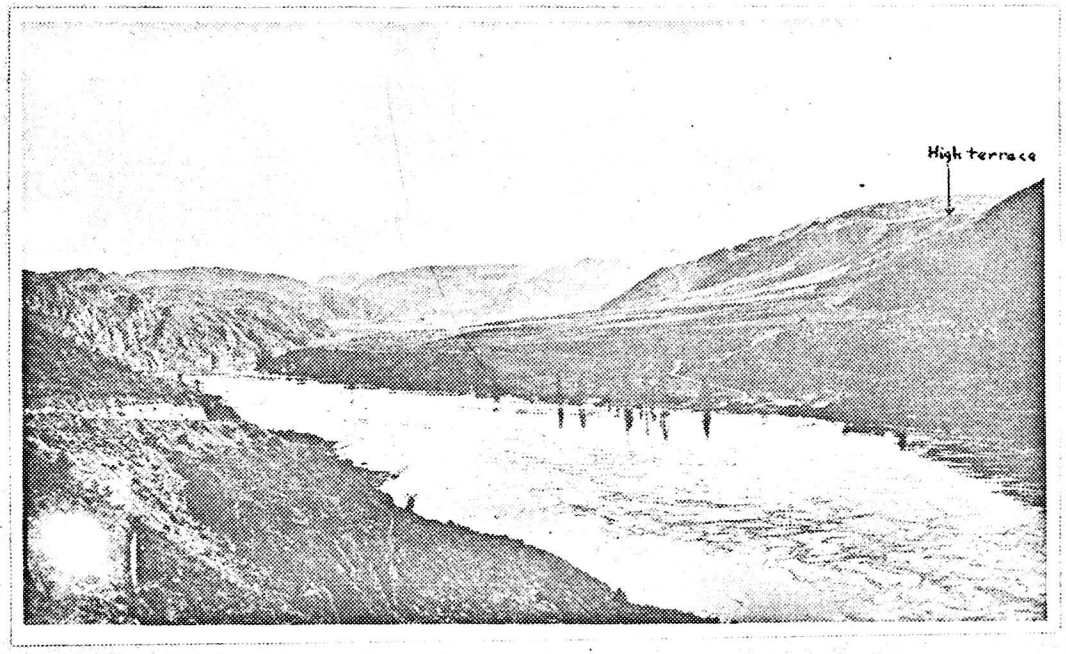


Figure 1.
Columbia River at Grand Coulee Ferry, looking downstream. The dam site is in the foreground. A great terrace of gravel and sand occurs on the right side, while the left wall is of granite. Note the extremely high river terrace remnant in the Grand Coulee, proving the former existance of the Columbia River entrance into the Grand Coulee.

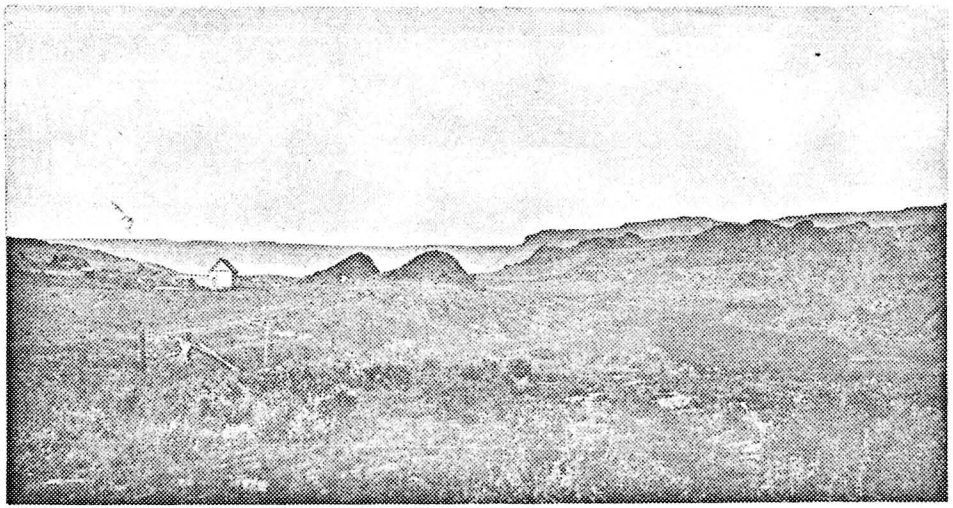


Figure 2.
View of the dam site in the north end of the Grand Coulee, looking southward. To the left of the school house is granite, while to the right is basalt, the contact being covered at the school house by a sandy terrace. The dam site is placed across this contact. The basalt beds dip slightly to the northeast forming the flank of a low anticline or fold passing through this area. In the construction of this dam special attention should be given to this contact and to the material beyond the ends of the dam to the great walls of the Coulee on either side.

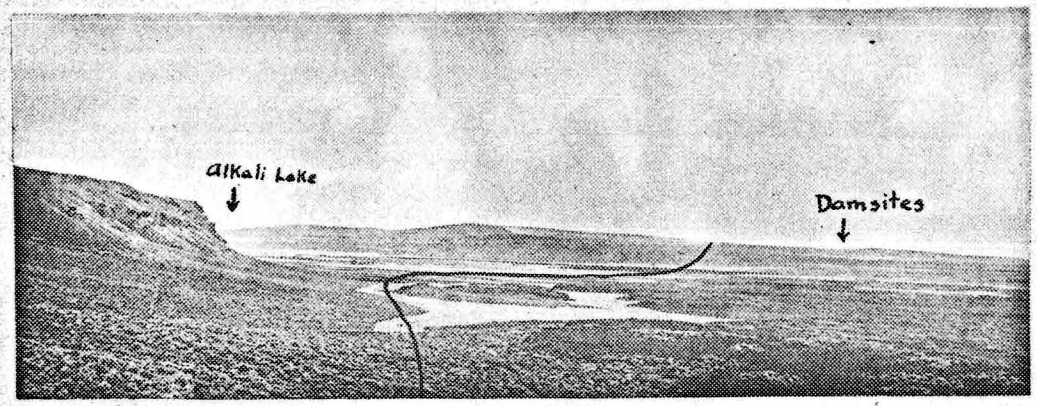


Figure 3.
The southern end of the Grand Coulee looking northeast. Two dam sites have been located here by the Columbia Basin Survey, north of Coulee City. Note the position of the monocline and fault, indicated by the black line. The low outcrops of basalt in the Coulee are beds which were formerly at a much higher relative elevation than those of the present bluffs. They have been displaced by great dips and probably a fault to their present position. The layers of basalt along this line, beneath the floor of the Coulee, undoubtedly are dipping at very steep angles, and they contain some rather porous layers.

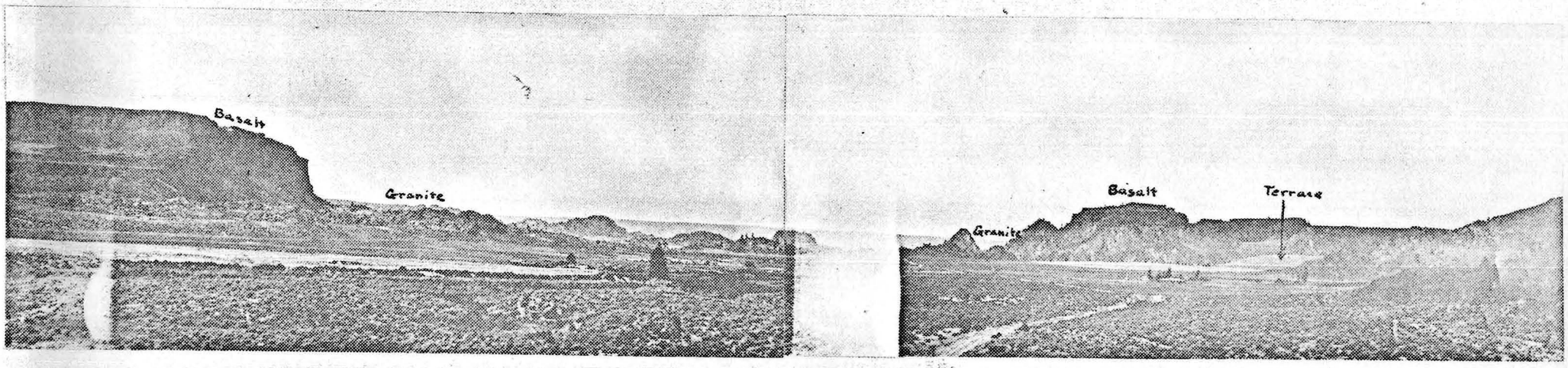


Figure 4.
Looking northward in the Grand Coulee, showing the relations of the rocks to one another. Steamboat Rock lies on the left, while the Coulee wall, consisting of granite, capped with black basalt, occurs on the right. The proposed reservoir would not quite enter this region. Note the remnants of the old terrace deposit.

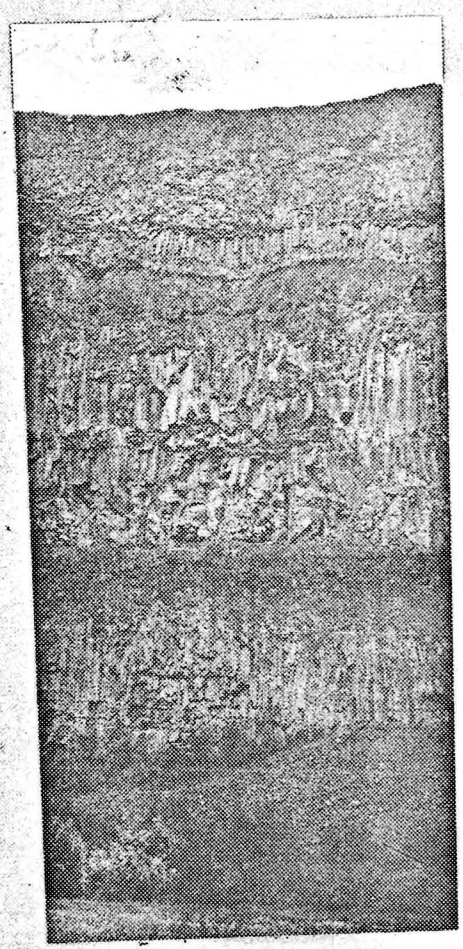


Figure 5.
A typical exposure of the Grand Coulee basalt. The water-line of the reservoir would, in this case, reach above the loose talus slope. Between the basalt layers are some porous beds. Near the top is a layer of agglomerate. (A).

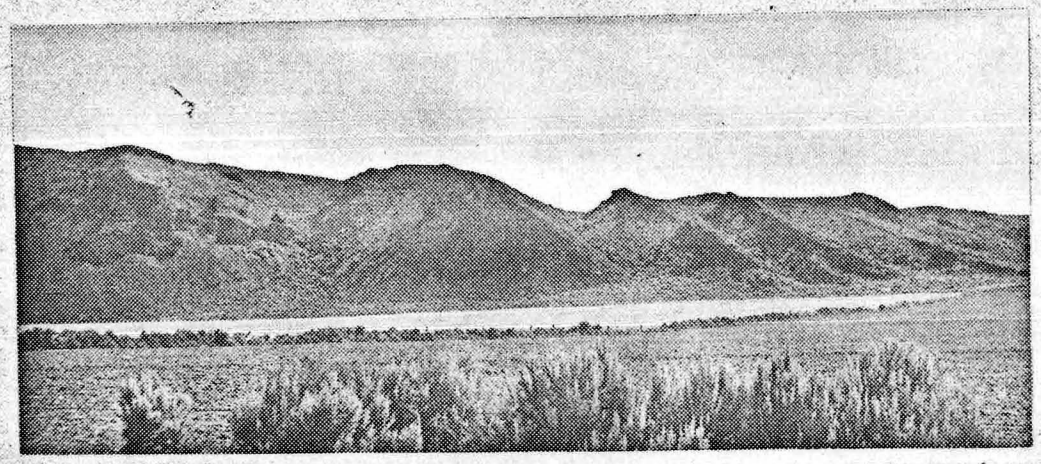


Figure 6.
The sharply dipping basalt beds of the monocline exposed in the east wall of the Coulee, north of Coulee City. The alluvial filling of the Coulee floor covers superficially the continuation of this monocline across the Grand Coulee. Some of these basalt layers are porous and agglomeratic, but most of them are fairly dense.

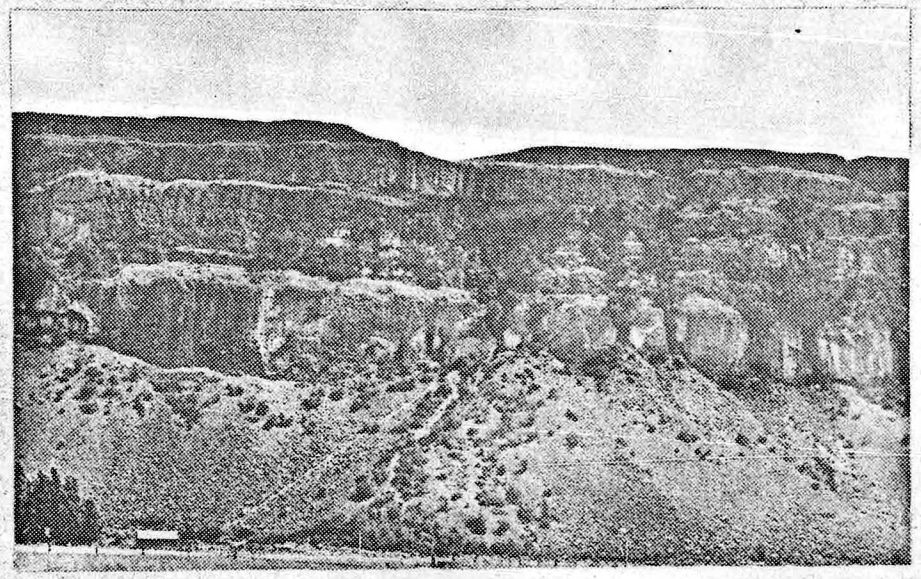


Figure 7.
The east wall of the Coulee, by the Art Lewis place. High up in the wall, far above the water-level of the proposed reservoir, where the vegetation is present, a spring seeps through a porus bed in the basalt and is piped to the farm house and used to irrigate an orchard.

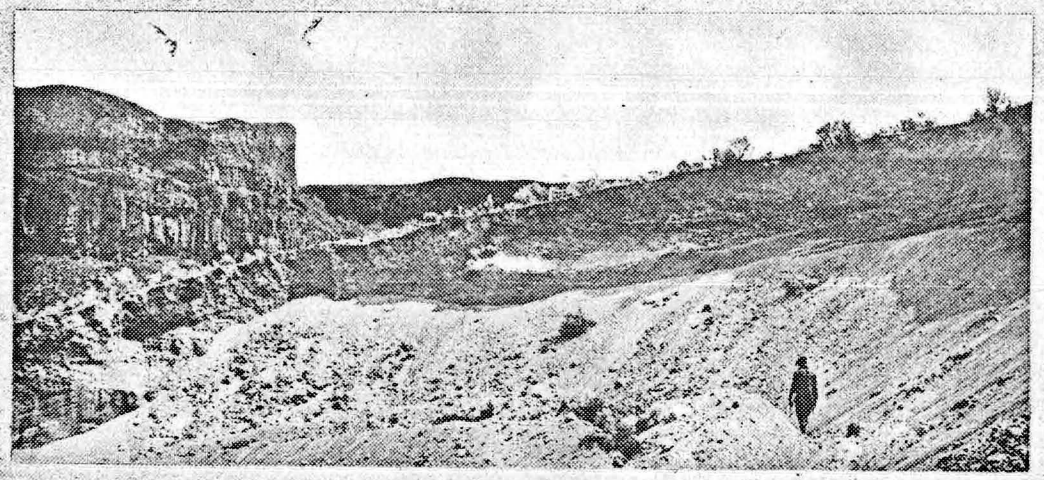


Figure 8.
The sand and gravel pit in an old high terrace in the Grand Coulee. This sort of material probably occurs as a layer upon the bed rock of the Coulee floor.

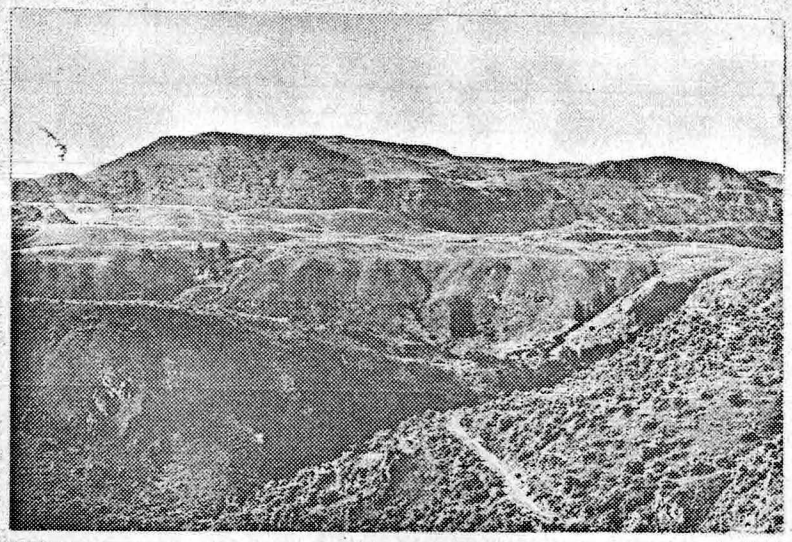


Figure 9.
The entrance of the Grand Coulee, not far from the Columbia River Gorge, looking southeastward. The large terraces in this picture lie at least 700 feet above the River and they continue from the region of the gorge to that of the Coulee. An old river channel of intermediate height lies near the foreground. These are historical features relative to some of the various courses followed at different times by the Columbia River.

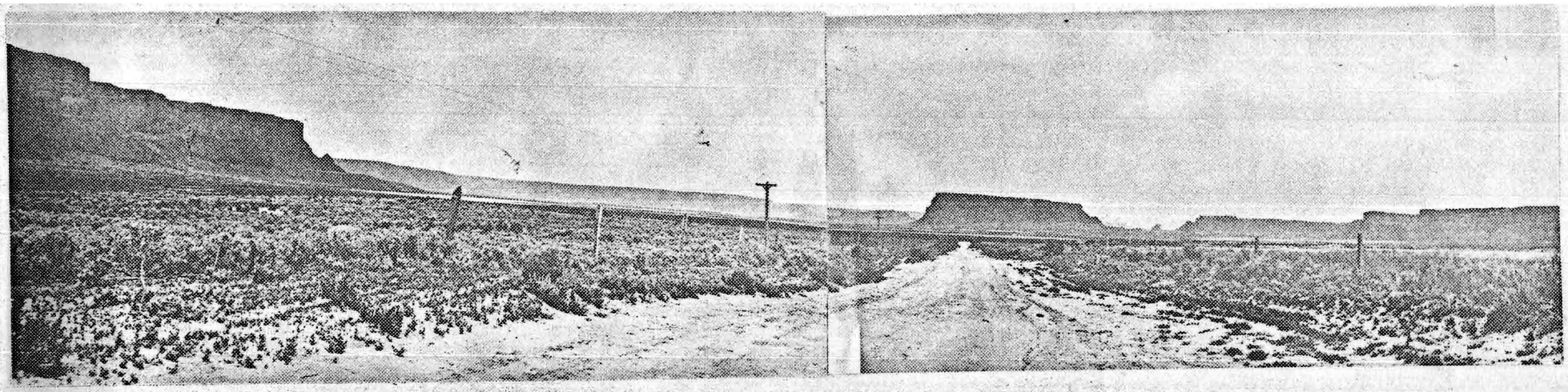


Figure 10.
Looking northward through the Grand Coulee towards Steamboat Rock. The proposed reservoir would lie only on the left side of Steamboat Rock. Devils Lake now lies in the depression to the left. The road shown in the picture is placed in a silt formation which fills the basin. This formation makes terraces when cut back by erosion. Note the higher gravel terrace to the extreme left against the west wall. These walls are probably 500 to 800 feet high.

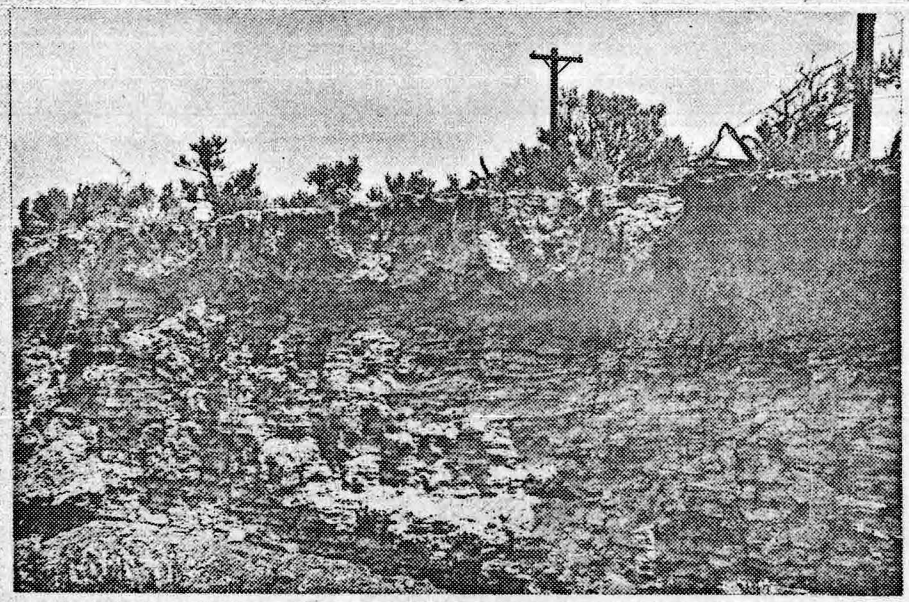


Figure 11. An exposure of the silt formation, a fine-grained, laminated clay-like material, which overlies water-bearing gravels which have been reached in wells fifty feet or so in depth.

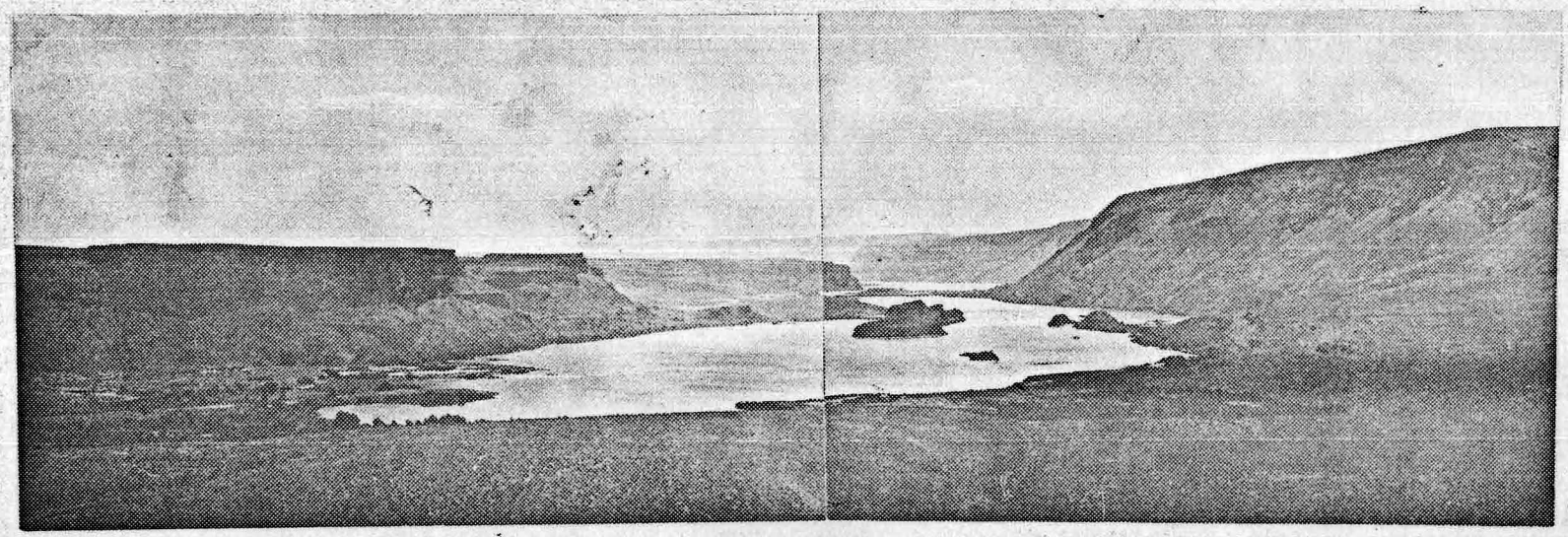


Figure 12.
View of Blue Lake, looking southwestward, and the dipping beds of basalt which form an abrupt monoclinal fold. The layers of rocks in the high bluff to the right plunge down and pass under the surface of the lake. The bluff to the left is composed of lava flows overlying the continuation of those flows represented in the higher cliffs to the right. Compare this picture with the explanatory section of the map.

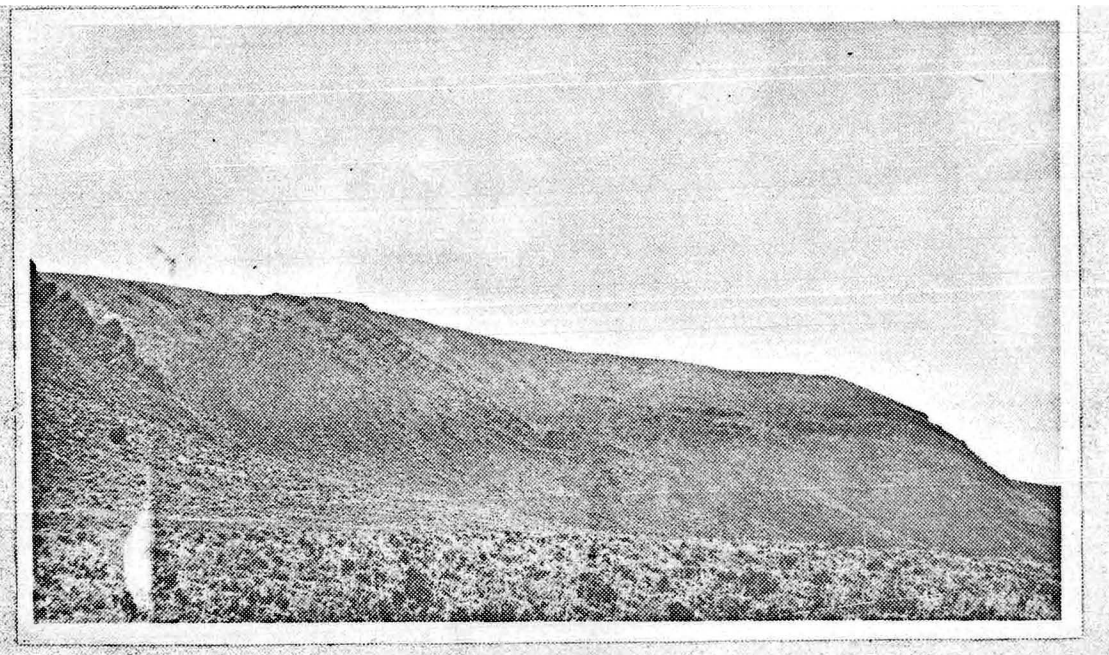


Figure 13.
An exposure of the monoclinal fold near Blue Lake, northeast of its exposure shown in figure 12. This view is of the bluff below and to the right of the camera in figure 12. A rough estimate of the vertical displacement of the beds in this region shows a difference of 1500 feet in elevation, between the upper and lower sides of the monocline. Such measurement is made in reference to one bed.

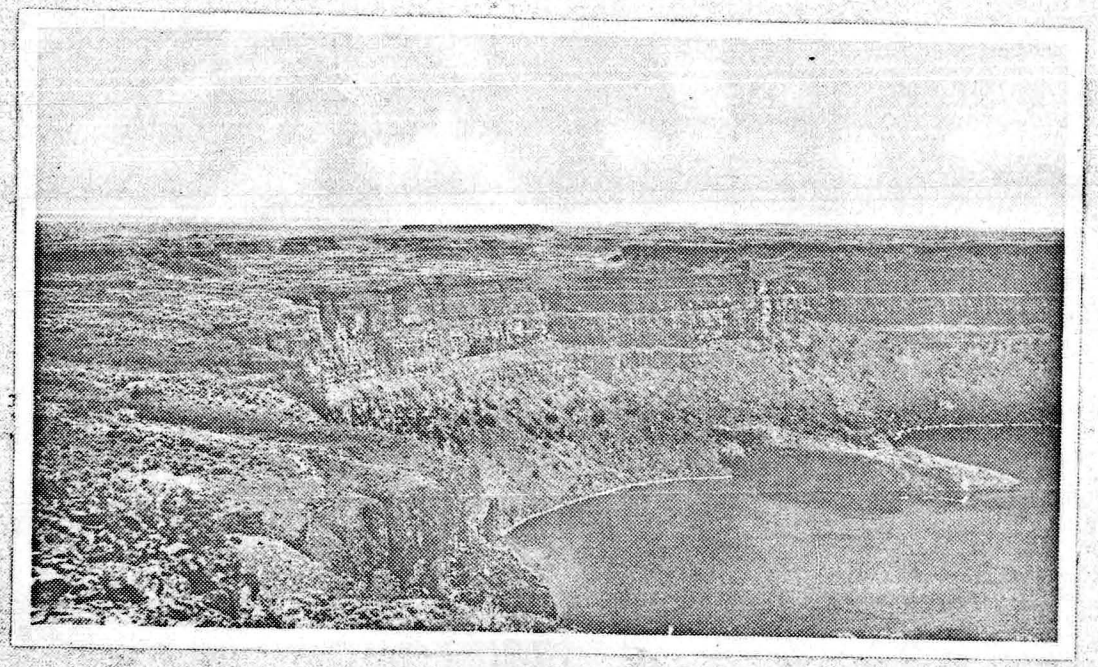


Figure 14.
Dry Falls, southwest of Coulee City, over which the Columbia River once fell after passing through the Grand Coulee, its upper channel. The basalt layers exposed here lie above the continuation of the basalt beds in the high walls of the Grand Coulee, which plunge and pass under the rocks shown in the picture.

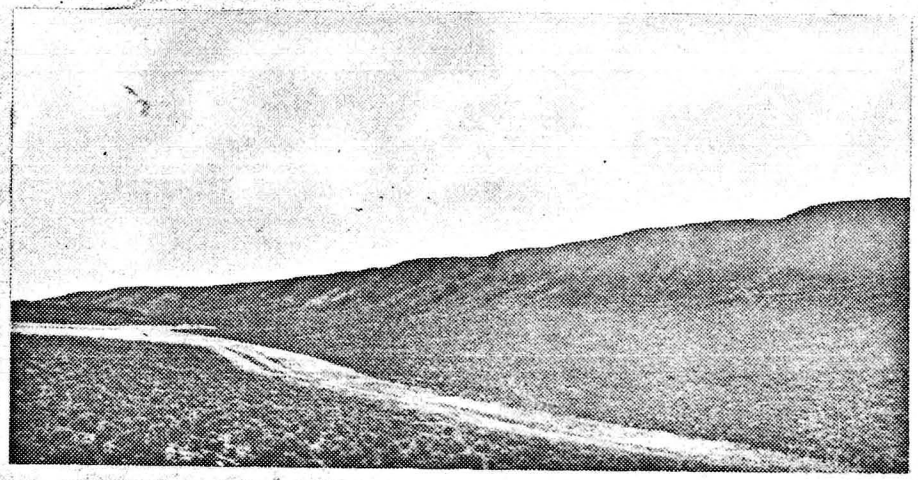
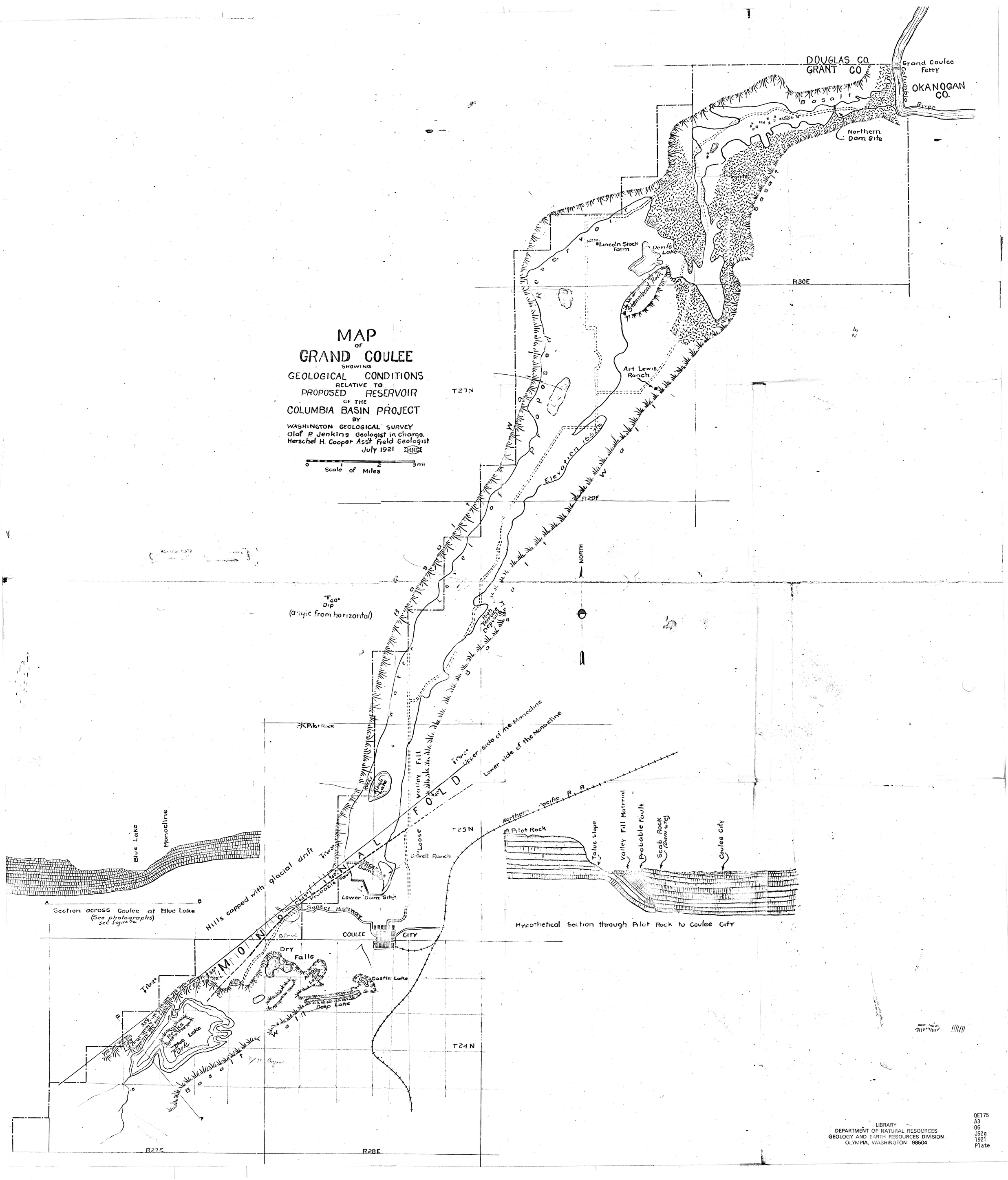


Figure 15.
Southwest view along the course of the monocline, looking toward the exposure in the west bluff of the Grand Coulee northwest of Coulee City. Note the basalt beds dipping or sloping towards the left at a steep angle.



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